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ABSTRACT

This paper describes the development and implementation of a project to prepare science support teachers to work in four junior high schools in Toledo, Ohio. The project was collaboratively developed by the Institute for Research on Teaching at Michigan State University, the Toledo school district, and the American Federation of Teachers. The concept of support teacher, based on the "master teacher" concept presented in the 1986 Carnegie and Holmes Group Reports, was developed around four closely related activities: (1) change the teaching-learning processes in the support teachers own classrooms; (2) support the change in the teaching-learning processes of other science classes by the use of observation and feedback; (3) use the departmental meetings and informal contacts for the diffusion of new ideas, new concepts, and new strategies, and to discuss problems of teaching and learning science in meaningful ways; (4) study research reports, conceptual articles, and articles about teaching-learning practices in order to conceptualize the redirection of the support teachers and science faculty teaching-learning practice. Results are presented from a preliminary analysis of data which focuses on support teacher training seminars, classroom observation, impact on student learning, and the processes of change. (IAH)

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HELPING SCIENCE TEACHERS HELP SCIENCE TEACHERS: A STUDY OF CHANGE IN JUNIOR HIGH SCHOOL SCIENCE

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HELPING SCIENCE TEACHERS HELP SCIENCE TEACHERS:

A STUDY OF CHANGE IN JUNIOR HIGH SCHOOL SCIENCE

If we keep doing what we're doing,
we'll keep getting what we're getting!
Linda Alford

I. A Glimpse at Change

The time: March 1988. The place: a junior high school in Toledo, Ohio. Laura, a science teacher, is being interviewed. The questions are: "One frequently hears the statement, 'It is important that students understand the content.' a) What does that mean to you? b) How do you know when students do not understand the content?" Laura answers:

> a) The content is getting the information that is in the textbook. I think it is important, but before I can get to the content I have to convince them that they can get the information. b) My students tend to question me. I frustrate them a lot because I never repeat myself. I will say the same thing in many ways.

Six months later when asked the same questions, Laura answered:

> a) Do they get the idea? The concept? Before this, my idea of their understanding was how well they did on their tests. But they were parroting back to me what I had given them and there wasn't much learning taking place. Understanding the content, for me, has changed. Using the mind stretchers and using the essay questions I am finding out more about what they understand. b) It used to be by my tests. Now is using the mind stretchers.

What happened during the six month period in between the two interviews? How can we explain Laura's change of views?

II. The Pre-History of the Change

The characters of this history are four science teachers teaching in four different junior high schools of Toledo, Ohio. For the sake of anonymity let us call the teachers Laura, Joan, Marc, and Dan. They will be the focal points of our description and analysis.

The history of the project this study is about really starts before March 1988. The project inserts itself in the many efforts being made to reform schools in the U. S.. Recent reports on the state of American schools have pointed out the low level of understanding students achieve in science and mathematics. Some of these reports

suggest that part of the solution to this problem comes from better prepared, supported and appreciated teachers (e.g. Holmes Group, 1986; Carnegie Forum, 1986). One of the ways of improving the teaching of science and mathematics in American schools seems to be helping teachers broaden their conception of teaching subject-matter, update their knowledge and skills, and introduce instruction as a dominant theme of teacher and school discourse. These three dimensions had been identified in previous studies of teaching practice as crucial (Gallagher, 1989).

The research team, during the Fall of 1987 continued the discussion and clarification of a concept of support teacher as a development of the idea of "master teacher" contained in the Carnegie and Holmes Group Reports (1986). Three main aspects were considered essential:

1) Centering the role and activities of support teachers on the teaching and learning of science and mathematics;

2) Improving the classroom practice of science and mathematics teachers by fostering and supporting change within a school based system;

3) Using the most recent contributions of research on teaching of science and mathematics to provide direction to the change intended.

While all this was being conceived and discussed in the research team, negotiations for a site to implement the concept of support teacher and study its viability and impact were already under way since 1986. The Institute for Research on Teaching at Michigan State University through one of its co-directors was studying and negotiating the possibility of implementation in one of the school districts afilliated with the American Federation of Teachers. From the very early stages of its conception this project was viewed as a collaborative effort between a University, a Teachers' Union and a School District.

The negotiation process resulted in the choice of Toledo as the site that the American Federation of Teachers thought held more promise. A pilot implementation was started in four junior high schools. The school district and the local teachers' union asked the junior high schools if they wanted to participate. In four of them the faculty was favorable and they nominated the possible candidates for the role of support teacher. The School district and the local representatives of the Teachers' union made the final choice based on the ratings of the candidates by the faculty of each school. Each one of the participant schools got a support teacher for science and a support teacher for mathematics. Only the four science support teachers will be object of this paper.

III. The History and Context of Change

In the first week of February, 1988 the research team composed by James Gallagher (professor of Science Education), Perry Lanier (professor of Mathematics Education), Linda Alford (teacher consultant), and Antonio Bettencourt (graduate assistant) started the training seminars with the eight chosen candidates. During the first year of the project the seminars were held during two days every month following closely each day the duration of a school day (6-7 hours). Both the teachers and the research team were exhausted in the end of the second day. Joan, one of the science support teachers later in the project would remember these first sessions as "leaving her completely exhausted but with a kind of nice feeling". As she explained the nice feeling was due to the sensation of learning new and challenging things. Laura was another example of the kind of commitment that existed in the eight support teachers from the very beginning. She had undergone major surgery and was still recovering when the seminars started. She attended and participated in every one of them. After the second day, exhausted, she would go to the hospital to receive major treatments that would make her be in bed the next day. We, in the research team believe that we are able to be describing this project and its achievements due in large part to the commitment, tenacity, and patience of the eight support teachers. The commitment of the eight teachers was also matched by the engagement of the research team.

The afternoon of the first day of the two day seminars was used for a meeting where we would discuss the day's meeting and reflect on what had happened. This reflection always ended up in the fine tuning of the next day's agenda. Sometimes the "fine tuning" went as far as the complete revision of the agenda. The return trip the next day would be also a discussion of the two days of seminar and the sharing of ideas about where and how to proceed next. Prior to each seminar the research team would meet in Michigan State for several hours (typically 2-3) in order to plan the seminars and discuss the directions to take.

The seminars had a dual purpose:

1) To study and develop with the eight teachers a concept of support teacher that would be sufficiently adapted to the needs of their schools and departments to be viable and also sufficiently new and different to promote some dissonance generative of change;

2) To document and understand the construction of the support teacher role by the research team and the eight teachers as well as the interactions between each teacher, his/her definition of the role, and each school/department context.

At the same time the training seminars started, the documentation-research process started also. The meetings, from the very first day were taped and field notes were written by team members. The eight teachers were frequently asked to write down opinions, concerns, ideas, difficulties, etc., and those materials collected to add to the data pool. The history presented in this paper is heavily based on those materials.

Slowly, in the course of the seminars, from the vaguely defined notion of the research team (see p. 3 above) and the teachers' own development and understanding a more coherent and "practical" concept started to emerge. The concept of support teacher was studied and developed around four different, but closely related activities:

1) Change the teaching-learning processes in the support teachers own classrooms;

2) Support the change in the teaching-learning processes of other science classes by the use of observation and feedback;

3) Use the departmental meetings and informal contacts for the diffusion of new ideas, new concepts, new strategies, and also to discuss problems of teaching and learning science in meaningful ways.

4) Study research reports, conceptual articles, and articles about teaching-learning practices in order to conceptualize the redirection of the support teachers and science faculty teaching-learning practice.

The purposes behind these four activities are easy to understand. Unless the support teachers underwent themselves a process of change they would not know how change in deeply engrained teaching-learning practice affects the teachers, the classes they teach, and ultimately the whole school. They would not also be cognizant of (hence sympathetic to) the fears, the sense of inadequacy, the sense of uncertainty, the discrepancy between what you want to accomplish and what you do accomplish that are constitutive of any process of change. They had to become themselves aware of how long, difficult, and threatening a change process is. Laura summed up this whole complex of emotions when towards the end of the first year she said:

> We have gone through a lot of soul searching and doubts about ourselves. We all thought that we were pretty good teachers until you guys asked us what were our students really learning.

Undergoing a personal process of change, while crucial, is not sufficient to induce and support other teachers processes of change. Very early in the seminars the support teachers learned how to observe

classes and engage in a constructive conversation about the events. The learning of the "how to look at", "what to look for", and "how to talk about it" (to use project jargon) was carried through readings, discussions and focused practice during the seminars. The materials for observation and feedback were provided by videotapes of classes. Some of the videotapes that served for practice during the seminars were of the support teachers teaching their classes. They were encouraged to do the videotaping as a way of observing they own class and themselves from another "point of view". The support teachers were themselves observed by the research team from the first month of the project. Later, each one of them was observed by the research team and the other support teachers. The purposes of these multi-level, multi-site, multi-media, multi-observer observations were multiple:

1) Document and understand the practice of the support teachers and its changes;

2) Induce and support the change of the support teachers practice through observation and feedback;

3) Show to the support teachers how the different forms and focuses of observation and feedback look in a real life situation;

4) Give the support teachers a look at classes from the "other side" (so to speak).

At the same time they were attempting to implement changes in their own classes, the support teachers were trying to refine their observation and feedback skills by using them with their peers. They were asked to observe one of the science teachers in their school and give him/her positive feedback about his/her class. The intent was to train them in the use of feedback and in the start of a support relationship that is built upon mutual trust. For this observation they were told to pick a teacher that would be cooperative. Later in the year the support teachers were asked to videotape one of their colleagues. After the videotaping the teacher was asked to view the tape alone and select the parts he/she wanted to talk about with the support teacher. Subsequently the support teachers started learning about constructive feedback aimed at changing practice. The observations and feedback by the research team started also being more geared towards the change of practice. The support teachers were also encouraged to try this with their peers.

Near the middle of the first year when the support teachers were still undergoing their intensive training the project was starting to be an object of curiosity in the schools where it would be implemented the next year. The support teachers were asked questions about what they were doing, what was going to happen, etc.. This curiosity started the informal conversation not only about the project but also about teaching and learning of science. This informal conversation

prepared the way for the support teachers to start a slow change in the character of the departmental meetings during the current second year. These meetings went from strictly procedural matters to discussions about science, teaching and learning.

All these efforts, disparate as they seem at first sight, were unified by a common preoccupation: teaching and learning of science. From the beginning the project team believed that all the support activities had to be built around what is central in science education: knowing science in a way that the students and the teacher both understand and appreciate. Every seminar had a sizeable portion (sometimes a whole day) devoted to science and mathematics teachers separate meetings. In these meetings content, strategies, and students' understanding were the center of discussion.

The support teachers in order to be able to change their practice and maintain an open climate of discussion in their schools had also to update their preparation. The research team and the support teachers from the beginning agreed that without serious study no change in practice could lead to improvement of science education in junior high school. Between every seminar, while trying to experiment new ways with their own practice, starting to observe their peers, and working informally on the school climate the support teachers were also reading articles about teaching and learning of science, about students' conceptions in science, about strategies like cooperative learning, about school change, about feedback, about observation, about peer-supported change in schools, etc.. This study has remained an integral part of each support teacher daily or weekly routine. As a matter of fact they are not only reading articles/books recommended by the research team they read voraciously articles that each one of them finds and shares with all the others. The following list of the readings done (or redone) by Marc since last September (directly copied from his records) is a good example:

- Making Group Work, Work
- The Earth as a Cosmic Body
- Is There a Relationship Between Science and Subjects Taught in School? (Research Guide)
- PDK Trains Master Teachers for Small Indiana School District
- On that "Note" (about taking notes)
- My Year Without a Textbook
- Science Teachers: A Dwindling Supply
- "Knowledge is power", "Thinking it through" - Steps in Setting-up a Cooperative Group Experience
- Understanding resistance
- Don't Be a Mean Teacher
- The Classroom Society
- Physics Toy Chest
- Research on Secondary School Science Teachers' Practices, Knowledge and Beliefs: A Basis for Restructuring

- Cooperative Learning and Student Achievement.

The history of the changes occurred in this project and sketched so far is necessarily incomplete. Many other events could be described and document transcriptions added. The purpose was not, however, to be exhaustive, but representative. We hope that the complex and intertwined nature of any process of school-based change was, if not captured, at least hinted at.

IV. Looking at Change Through Changes

The richness and quantity of the data already gathered in the project files and still being collected does not permit a thorough analysis. In the second year of the project (the first year of implementation) four observers spend an entire week each three months in the schools following the support teachers like a shadow, taking notes, taping meetings, taking photos, collecting "artifacts", etc..

The next few pages present some of the findings of a very preliminary (better said exploratory) analysis of the data done so far. More than showing how the data may be interpreted the purpose is to show the promise of a more detailed analysis. One of the aspects we consider crucial in this project is the tracing and understanding of the processes of change in the individual teachers, their departments, and their schools through time. This cannot yet be done satisfactorily. Another set of data just starting to be analyzed are the student data. In the impossibility of giving a sweeping account of the change process with the support teachers we will content ourselves for now with showing some areas of more drastic change.

The classroom practice of the support teachers (and to a lesser degree that of their peers) is showing very encouraging changes. Teachers started listening more carefully to student answers and probing beyond the right or wrong. The phrase: "Don't give me the book definition, tell me what it means to you" is frequently heard in the four classes of the support teachers. In December, 1988 one of the observers reported the following event in Laura's class:

> Laura had given a written assignments about condensation and precipitation in the formation of clouds and rain. A student punched his desk and said: "I don't understand!" Laura moved near him and punched his desk too. "What is it that you don't understand?" she asked. The student punched again his desk and said: " I don't understand condensation and precipitation." Laura punches his desk again and asks: "Is precipitation the same thing as condensation?" The student punches his desk and answers: "No." Laura is not satisfied and punches back: "Why?" Student answers by distinguishing the two processes. Only then, Laura "lets him off the hook".

Laura had assumed the student's language in order to deflect his frustration and at the same time probe his understanding. When asked if this was different from the year before, Laura smiled and said: "It would never have happened before". The same kind of scene (less intense, perhaps) is now part of the other three classrooms also.

The questioning of the students and probing of their answers has led the teachers to a heightened awareness of students previous knowledge in science. This knowledge is made public, valued, used, and, if necessary, corrected. Answering to the question of how he knew when students did not understand, Dan said:

> Testing did not always tell you what they did or did not know. If you can sit with the kid and have him tell you what he was thinking - then you know.

Joan says many times that she finds herself "listening more to the kids and talking less, having them play it back in their own words" to her. The support teachers had found that by sixth grade students are pretty good at "hiding behind words and memorized definitions".

Another aspect of the classroom practice that has changed dramatically in the four support teachers classes is the social organization of learning. Teachers are incorporating more and more group activities where students have to put together different pieces of information. The use of the group work was restricted before to the lab activities. Nowadays it is used in the lab and in the interpretation of questions, situations, etc..

In order to have students construct science in a coherent way the teachers are not only allowing more discussion and interaction but also providing cognitive strategies that help that construction. Most of the teachers started using concept-mapping as a tool to help students link science concepts in creative and meaningful ways. Both the cooperative groups and the concept maps generated the need for higher level tasks that the teachers are also trying to provide more often. Most of them will now speak with dissatisfaction of the worksheets that are published as being rote and boring.

The preoccupation with student knowledge and understanding has generated different assessment needs. The teachers are giving more essay questions in their tests and homeworks in order to have insights into the students' understanding. They all started using "mind-stretchers" in the beginning of their classes. "Mind-stretcher" is usually an open-ended question that links the day's lesson to the previous lesson while providing the student with an opportunity to write into his own words.

An event in Marc's class will illustrate the importance the teachers are giving to student expression of concepts and ideas in science:

> Marc was going to start a unit on Astronomy some weeks before Christmas. He asked the students in the first class to write what they could remember about the Universe in a piece of paper. To do this he gave them 20 minutes. Most students, according to him, wrote three to five lines, some one or two words. He then collected these papers and kept them. At the end of the unit he gave them the same piece of paper, the same task, and the same time. Most students wrote 1-2 pages, some asked for more paper and others for more time. No one wrote less than half a page. Marc took the papers home wrote some comments and gave them back to the students saying: "Take that to your parents and show them how much you have learned. That will be a good Christmas present".

Their discourse about the classes and the students has also shown some interesting changes. Initially there was a centration in "problem students" as a source of frustration where the discourse revolved around "bad kids". "Oh you have that one in your class... Well I had him last year and..." Now the discourse centers in the preoccupation of not reaching these students. They started to look at ways to engage them in the class activity. "This student here has a problem of confidence. Every time he volunteers, I go for it and give him all the encouragement." These were Marc's own words referring to a student in his class.

So far the school climate in the four schools has improved from suspicious or skeptical to curious and hopeful. Teachers started questioning and resisting the changes but now are for the most part conquered. In every one of the four schools there is a teacher that is resistant and negative causing headaches to the support teachers. There is another in the opposite extreme, eager to try new things and be helped. The others (2 or 3) fall in between.

The research team and the support teachers did not expect any significant differences in student achievement within or across the four schools. The characteristics of the project entail a slow diffusion of effects. Joan, however, reported that her students show better results in the achievement tests. We have not had the time to probe further on this matter but it is a sign of hope.

V. So What?

This preliminary analysis of the data adds confirmatory evidence for the possibility and benefits of extended professional roles for science teachers. In the present reform effort, updating teachers' knowledge and skills is a crucial dimension.

The results illustrate the extremely beneficial effects a support teacher can have not only in teachers but also in schools and especially in students. The authors do not think that it will solve all the problems of science education but they have presented evidence that points to the potential of the solution.

The implementation of a Support Teacher program is costly but is definitely worth the initial expenses given its multiplier effect. A support teacher by working closely with his/her peers in the school, slowly but steadily reaches all students.

The concept of Support teacher can be modified to be extended to all levels of public schooling. Two dimensions seem to be crucial and should not be modified: the school base of the support and the centration on science learning.

The research team is currently negotiating with the American Federation of Teachers the implementation of similar programs in other school districts throughout the U.S..

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